Health Consultation

Analysis of Cancer Incidence near the former Mercer Rubber Company Site

Hamilton Township, Mercer County, New Jersey
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Purpose

At the request of concerned citizens living near the former Mercer Rubber Company site, cancer incidence was evaluated for two census tracts near the facility in Hamilton Township, Mercer County. Total cancer incidence and 13 specific cancer types were evaluated in this investigation. The specific cancers types were selected because they represent cancer groupings that may be more sensitive to the effects of environmental exposure, though not necessarily related to potential facility contaminants.

Background and Statement of Issues

The former Mercer Rubber Company was located on the east side of Mercer Street in census tract 30.07 in the Hamilton Square section of Hamilton Township, Mercer County. The small factory had been in operation on the 2.5 acre site from 1866 through 1993. The company specialized in the manufacturing of molded rubber mechanical products, rubber sheeting, conveyor belting, and rubber expansion joints.

Prior to the 1930s, rubber products were manufactured from natural rubber. Synthetic rubber first became available in the United States in the early 1930s. Given the typical raw materials and the processes used in rubber manufacturing, petroleum hydrocarbons and base-neutral compounds (associated with lubricants and fuel oils), metals (associated with catalysts and certain vulcanization processes), and solvents were likely used in former operations at the site. The most recent operations involved rubber processing for the manufacture of specialty fittings, gaskets, and hosing.

New Jersey Department of Environmental Protection's Right-To-Know reports indicate that numerous chemicals and chemical mixtures were stored on-site including, but not limited to, toluene, butadiene, benzene, petroleum hydrocarbons (from gasoline and fuel oil), and, to a lesser extent, acrylonitrile (ATSDR 2006). Past air emissions of toluene are documented (ATSDR 2006). While there are no data available on past emissions during plant operation, except for toluene, possible exposure to residents living near Mercer Rubber include air emissions to other volatile organic compounds. Groundwater contamination via private potable wells and vapor intrusion either in the past or present is also possible.

Environmental evaluations conducted for on-site contamination at the closure of Mercer Rubber concluded that certain areas of the property were subject to remedial action due to elevated soil concentrations of petroleum hydrocarbons, semi-volatile organic compounds, polychlorinated biphenyls, and metals (Environmental Liability Management 1993, 1994, 1995).

The Mercer Rubber site was remediated in 1995, and sold for residential development in 2000. Currently, there are single family homes located on the site. The area surrounding the site is primarily residential with some commercial and light industrial operators within one-half mile of the site. Directly across the street from the site is Sayen Gardens, a public park.

Methods

Study Area and Population

The Mercer Rubber Company Site study area for the evaluation of cancer incidence consisted of the entire population residing in two census tracts (30.06 and 30.07) in Hamilton Township, Mercer County. Population counts for the area were determined from 1980, 1990, and 2000 U.S. Census data (US Census Bureau 1980, 1990, 2000).

Cancer Case Ascertainment and Study Period

The New Jersey State Cancer Registry was used to determine cancer cases. The cancer registry is a population-based cancer incidence registry covering the entire state of New Jersey. By law, all cases of newly diagnosed cancer are reportable to the registry, except for certain carcinomas of the skin. In addition, the registry has reporting agreements with the states of New York, Pennsylvania, Delaware, Maryland, North Carolina, and Florida. Information on New Jersey residents who are diagnosed in those states is supplied to the New Jersey State cancer registry. The registry has been in operation since October 1, 1978.

The study period for this investigation was January 1, 1979, through December 31, 2001. A "case" was defined as an individual who was diagnosed with a new primary malignant cancer during the study period while residing in one of the two study census tracts. Registry cases identified only through search of death records were excluded from this evaluation. Information on important cancer risk factors, such as genetics, personal behaviors (e.g., diet and smoking), or occupational history, is not available from the cancer registry.

Data Analysis

Analyses were completed for all malignant cancer types combined and for select cancer types for two census tracts in Hamilton Township (see Figure 1). The select cancer types analyzed include bladder, brain and central nervous system (CNS), female breast, colorectal, esophageal, pancreas, lung, leukemia, non-Hodgkin lymphoma, liver, bone, stomach, and kidney. These cancer types were evaluated because they represent cancer groupings that may be more sensitive to the effects of environmental exposures. Males and females were evaluated separately.

Standardized incidence ratios (SIRs) were used for the quantitative analysis of cancer incidence in the study area (Kelsey et al. 1986; Breslow and Day 1987). The SIR is calculated by dividing the observed number of cases (from the registry) by an expected number for the surveyed population over the time period reviewed.

The expected number was derived by multiplying a comparison population's age-sex-specific incidence rates and the study area age-sex-specific population figures. The comparison rates used to derive the expected number of cases were the New Jersey average annual incidence rates for 1979 to 1999. The study area age-sex-specific population was determined from the 1980, 1990, and 2000 U.S. Census data (Census 1980, 1990, 2000). The analysis used 18 age-specific population groups.

The observed and expected numbers are evaluated by interpreting the ratio of these numbers. If the observed number of cases equals the expected number of cases, the SIR will equal 1.0. An SIR less than 1.0 indicates that fewer cases are observed than expected. An SIR greater than 1.0 indicates that more cases than expected are observed.

Random fluctuations may account for some SIR deviations from 1.0. The statistical significance of deviations from SIR equal to 1.0 was evaluated using a 95% confidence interval (CI). The 95% CI was used to evaluate the probability that the SIR may be greater or less than 1.0 due to chance alone, and was based on the Poisson distribution (Breslow and Day 1987; Checkoway et al. 1989). If the confidence interval includes 1.0, then the estimated SIR is not considered to be statistically significantly different than 1.0.

Results

Table 1 presents the study area (census tracts 30.06 and 30.07) population by race and sex for the years 1980, 1990, and 2000. The study area population, all races combined, dropped slightly during the study period from a high in 1980 (10,019) through 1990 (9,688) to 2000 (9,522) and represented approximately 11% to 12% of the total Hamilton Township population. Approximately 95% of the study area population was white, while the proportion of females was slightly higher than males.

Table 2 presents the number of malignant incident cancer cases by race, sex, and age group for the study area. A total of 1,141 cases were diagnosed in the study area population over the 23 year study period and represented approximately 11% of the total cases for Hamilton Township (10,192). A total of 187 (1.8%) of the Hamilton Township cases could not be given a census tract code due to missing/incomplete address (117) or rural route/post office (P.O.) box address only (70). About half of the study area cases were male and 98% were white. Nearly 92% of the study area cases were diagnosed after age 44 while 6 cases were diagnosed under age 20. Of the study area cases, 63 (5.5%) were attributable to the Hamilton Continuing Care Center located in census tract 30.06.

Table 3 presents cancer incidence in the study area by cancer type for all race-sex groups combined. The most frequently diagnosed cancer types include breast, colorectal, lung, and prostate, representing about 55% of all incident cancers in the study area. The frequency of these cancer types is consistent with New Jersey statewide cancer incidence data.

Table 4 presents standardized incidence ratio (SIRs) results for the Mercer Rubber study area by sex. Overall cancer incidence was found to be close to the expected based on average state rates. Statistically significantly elevated SIRs include bladder cancer in males (SIR=1.4; 95% CI=1.1, 1.8), and brain/CNS cancer in females (SIR=1.9; 95% CI=1.0, 3.2). Other elevated cancer types, although not statistically significant, include leukemia in females (SIR=1.3), brain and central nervous system cancers in males (SIR=1.3), esophageal cancer in females (SIR=1.5), non-Hodgkin lymphoma in females (SIR=1.3), and bone and joint cancer in males (SIR=1.6). None of the SIRs were statistically significantly low.

Discussion

The purpose of this investigation was to evaluate cancer incidence in a population living relatively near to areas potentially contaminated by the former Mercer Rubber Company in Hamilton Township. The occurrence of cancer (all sites combined) over the 23-year observation period was similar to the expected (on the basis of average state rates). Bladder cancer in males and brain/CNS cancer in females were significantly higher than expected.

Cancer is a group of more than 100 different diseases (i.e., cancer types and subtypes), each with their own set of risk factors. The multifactorial nature of cancer etiology, where a given type of cancer may have more than one cause, complicates the evaluation of potential risk factors and specific disease outcomes. Documented chemical emissions from Mercer Rubber is limited to toluene, but benzene, butadiene, petroleum hydrocarbons, and, to a lesser extent, acrylonitrile are highly likely to have been emitted (ATSDR 2005). Benzene is considered to be a human carcinogen and has been associated with the development of a particular type of leukemia called acute myeloid leukemia (ATSDR 1997; NJDHSS 1994). Butadiene is a probable carcinogen in humans with evidence that it causes lymph and blood cancer in humans and has been shown to cause cancers in multiple organs in animals (EPA 2002, NJDHSS 1992a). Acrylonitrile is considered to be a human carcinogen based on animal studies and may be associated with lung and prostate cancers (NTP 2005). Little evidence exists that toluene is associated with cancer incidence in humans, and it has not been shown to cause cancer in animals (ATSDR 2000; NJDHSS 1992b).

In the current analysis, bladder cancer was statistically significantly elevated in the study area for males (SIR=1.4), but not females (SIR=0.8). Brain/CNS cancer was statistically significantly elevated in females (SIR=1.9), but found to be slightly elevated in males (SIR=1.3). The incidence of leukemia was slightly elevated, though not statistically significantly, for males (SIR=1.1) and females (SIR=1.3) over the study period. Other cancer types that were elevated, although not statistically significant, include esophageal cancer in females (SIR=1.5), non-Hodgkin lymphoma in females (SIR=1.3), and bone and joint cancer in males (SIR=1.6).

The causes of brain/CNS cancer are largely unknown, but a variety of genetic and environmental factors have been suggested (National Cancer Institute 1996). The only established environmental risk factor for brain/CNS cancer is high dose ionizing radiation (American Cancer Society 2004a). Certain occupations and industrial exposures have also been implicated as possible risk factors for brain/CNS cancer including chemists, embalmers, anatomists, precision metal workers, farmers, synthetic rubber and polyvinyl chloride manufacture, refining of crude oil and production of petroleum based chemicals, manufacture of pharmaceuticals, and the nuclear fuels and weapons industry (National Cancer Institute 1996).

The greatest risk factor for bladder cancer is smoking (American Cancer Society 2004b). Smokers are more than twice as likely to get bladder cancer as nonsmokers. Smoking is estimated to be responsible for 48% of bladder cancer among males and 28% among females. Certain industries have been linked with increased bladder cancer including rubber, textile, leather, and paint manufacturing (Monson 1996; American Cancer Society 2004b).

A limitation of cancer studies of this type is the inability to assess past exposure levels in the population. Important information needed to assess a cause-effect relationship includes data on actual personal exposure to the contamination and other relevant risk factors over time. That is, who was exposed and who was not exposed and the magnitude of the exposure that did occur. Because personal exposure information does not exist, residential proximity to the contaminated site was used as a surrogate measure for potential past environmental exposure. This was accomplished by analyzing the population living in two census tracts around the former facility (Mercer Rubber was located on the street that separated the two census tracts). Although proximity to the site may be a reasonable surrogate for past environmental potential exposures at the time the study was designed, it is also unlikely that all of the residents in these areas were exposed to the contamination. This would result in misclassifying some of the study area as exposed when they are not. Additionally, the length of residence of each case is unknown, thereby potentially adding to exposure misclassification. The consequence of exposure misclassification would be to bias the results toward not finding an association (i.e., no exposure-health outcome relationship).

Another interpretation problem is that cancer is a chronic disease that takes many years after exposure to reveal itself as a clinical disease. The information supplied by the cancer registry provides only an address at time of diagnosis for each case. No information is available on length of time an individual may have lived at the address before diagnosis. It is possible that some cases are new, short-term residents with little or no exposure to the site. Furthermore, former residents who moved out of the study area before diagnosis are not available for analysis. Population mobility cannot be accounted for in this analysis.

Additionally, when researchers independently examine statistical associations for a large number of comparisons, it is likely that some number of statistically elevated or low SIRs will occur by chance alone. While it is possible to statistically correct for this concern, opinions differ on whether such corrections are needed. In this analysis, confidence intervals are presented without adjustment for multiple comparisons.

The approach used for this descriptive cancer investigation was census- based. The population of two census tracts in Hamilton Township and the State of New Jersey were reviewed in order to calculate age standardized incidence rate ratios for the study area. This census approach (ecologic design) is a practical surveillance or screening method for cancer incidence. Although this approach is well suited for providing a picture of cancer incidence in the specific localities, cause-effect relationships cannot be evaluated. Important information on potential risk factors (such as genetics, environmental factors, occupation, etc.) that might explain the results, were not available for analysis using this type of study design.

Conclusions and Recommendations

The overall cancer incidence (all cancers combined) was not elevated in the Mercer Rubber study area. Brain/CNS cancer was statistically significantly higher than expected in females, but only slightly elevated in males. Bladder cancer was statistically significantly higher than expected in males, but lower than expected in females. Although brain/CNS and bladder cancers

have been associated with work in the rubber industry, the inconsistency between the SIR results for males and females for these cancers argues against an environmental exposure in the community. Leukemia, a cancer type which is of particular concern due to the potential site contaminants (benzene and butadiene), was found to be slightly elevated, though not statistically significant. Because of the inconsistency in the results for the sexes for cancer types significantly elevated and the lack of significant elevation in leukemia the current analysis provides little evidence that the rate of cancer incidence in the study area population was affected due to potential environmental exposure from the site. Other plausible explanations for the elevated SIRs include other unmeasured risk factors in the community (e.g., tobacco consumption or occupational exposures) or by chance alone.

The NJDHSS and ATSDR should continue to work with community representatives to determine if there are additional health concerns in the community. Additionally, NJDHSS and ATSDR should continue to meet with community representatives to determine the most appropriate health education materials and outreach strategies to inform the general population about the environmental issues related to the Mercer Rubber site.

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Certification

This health consultation was prepared by the New Jersey Department of Health and Senior Services under a cooperative agreement with the Agency for Toxic Substances and Disease Registry. This health consultation is in accordance with approved methodology and procedures existing at the time it was initiated.

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The Division of Health Assessment and Consultation (DHAC), ATSDR, has reviewed this health consultation and concurs with its findings.

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Tables and Figure

Table 1. Mercer Rubber Study Area
Hamilton Township Census Tracts 30.06 and 30.07
Population by Race and Sex
U.S. Census Bureau Data

Characteristics	1980	1990	2000
Total Study Population	10,019	9,688	9,522
% of Hamilton	12.1%	11.2%	10.9%
Sex			
Male	4,826	4,726	4,544
Female	5,193	4,962	4,978
Race*			
White	---	9,415	9,105
Black	---	39	76
Multiple Races	---	---	97
Other/Unknown	---	234	244

* Race not available by census tract for 1980 population. Multiple race reporting began in the 2000 census.

Table 2. Mercer Rubber Study Area
Hamilton Township Census Tracts 30.06 and 30.07
Malignant Cancer Incidence (1979-2001)
Select Case Demographic Characteristics*

Characteristics	Census Tracts 30.06 and 30.07
Total Cases	1,141
Sex	
Male	566
Female	575
Race	
White	1,119
Black	11
Other/Unknown	11
Age at diagnosis	
0 – 19	6
20 – 44	87
45 – 69	529
70+	519

* Data are from the New Jersey State Cancer Registry, New Jersey Department of Health and Senior Services.

Table 3. Mercer Rubber Study Area
Hamilton Township Census Tracts 30.06 and 30.07
Malignant Cancer Incidence (1979-2001) by Cancer Type
All Races Combined*

Cancer Type	Census Tracts 30.06 and 30.07
Oralpharynx	25
Esophagus	12
Stomach	22
Small Intestine	<5
Colorectal	160
Liver	<5
Pancreas	20
Other Digestive	9
Lung	151
Other Respiratory	17
Bones and Joints	<5
Soft Tissue	<5
Skin	41
Breast	169
Cervix	14
Uterus	37
Ovary	29
Other Female Genital	<5
Prostate	149
Other Male Genital	9
Bladder	74
Kidney	22
Other Urinary	<5
Eye	<5
Brain and Central Nervous System	24
Endocrine	12
Hodgkin Disease	9
Non-Hodgkin Lymphoma	44
Myeloma	9
Leukemia	32
Miscellaneous/Other	35

* Data are from the New Jersey State Cancer Registry, New Jersey Department of Health and Senior Services.

Table 4. Mercer Rubber Study Area: Hamilton Census Tracts 30.06 and 30.07 SIR Analysis by Cancer Type and Sex: All Races Combined

Cancer Type	Sex	Observed	Expected	SIR[1]		95% CI
All Cancers Combined	Male	566	582.9	0.97		0.89 – 1.05
	Female	575	559.8	1.03		0.94 – 1.11
Bladder	Male	62	43.7	1.42	*	1.09 – 1.82
	Female	12	15.7	0.77		0.40 – 1.34
Brain/CNS	Male	11	8.5	1.29		0.64 – 2.31
	Female	13	6.9	1.87	*	1.00 – 3.20
Colorectal	Male	80	83.2	0.96		0.76 – 1.20
	Female	80	79.4	1.01		0.80 – 1.25
Esophageal	Male	7	9.3	0.75		0.30 – 1.55
	Female	5	3.3	1.51		0.49 – 3.51
Kidney	Male	12	16.2	0.74		0.38 – 1.30
	Female	10	9.8	1.02		0.49 – 1.88
Leukemia	Male	17	14.9	1.14		0.67 – 1.83
	Female	15	11.4	1.32		0.74 – 2.17
Liver	Male	<5	NR	0.85		0.23 – 2.18
	Female	0	2.1	0		–
NHL	Male	19	21.4	0.89		0.54 – 1.39
	Female	25	19.0	1.31		0.85 – 1.94
Stomach	Male	14	15.7	0.89		0.49 – 1.50
	Female	8	10.0	0.80		0.34 – 1.57
Lung	Male	86	102.8	0.84		0.67 – 1.03
	Female	65	62.2	1.05		0.81 – 1.33
Bone and Joint	Male	<5	NR	1.64		0.18 – 5.91
	Female	0	1.0	0		–
Breast	Female	168	169.9	0.99		0.84 – 1.15
Pancreas	Male	9	12.9	0.70		0.32 – 1.32
	Female	11	13.3	0.82		0.41 – 1.48

[1] Note: *= statistically high, **= statistically low, NR= not reported because observed <5.
Data are from the New Jersey State Cancer Registry, New Jersey Department of Health and Senior Services.

Figure 1. Mercer Rubber Study Area